TRANSFER OF THERMAL ENERGY

Direction of Thermal Energy Flow

Thermal energy always flows from a region of **higher** temperature to a region of **lower** temperature**.**

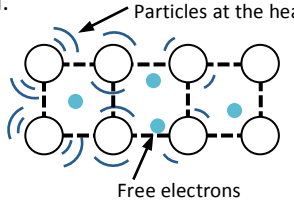
The greater the **temperature difference**, the greater the heat transfer.

Conduction

Conduction is the transfer of thermal energy without a flow of material medium.

Mechanisms of conduction

1) Vibrations of particles
   - The particles at the heated end of the medium gains kinetic energy and vibrates more vigorously about their fixed positions.
   - They collide with their neighbouring particles, transferring energy towards the non-heated end.



2) Free electron diffusion (metals only)
   - The free electrons at the heated end absorbs thermal energy, and gains kinetic energy.
   - They move freely throughout the metal.
   - They collide with the atoms at the non heated end, increasing their vibrational energies.

Solids are the good conductors of heat, followed by liquids and gases.

Metals are the better conductors of heat compared to non-metals (wood, plastic).

As a result, metals often feel *cool* to the touch as they remove heat more rapidly than non-metals.

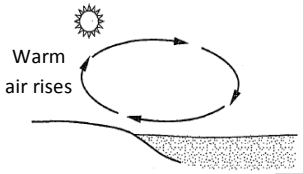
Convection

Convection is the transfer of thermal energy by movement of heated fluid particles due to differences in densities.

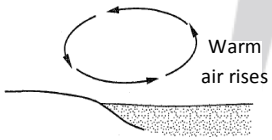
Formation of convection currents

1) When a fluid is heated, the particles near the heat source receives thermal energy by *conduction*.
2) The heated fluid expands, volume increases and its density decreases. The less dense fluid rises.
3) The cooler, denser fluid above sinks, forming a convection current transferring thermal energy.

Formation of land/sea breezes



- During the **day**, the land is heated up faster than the sea.
- The air above the land is warmer, so it rises.
- The cooler, denser air from the sea flows in to replace the rising hot air, forming sea breeze.



- At **night**, the sea loses heat slower than land.
- The air above the sea is warmer, so it rises.
- The cooler,denser air from the land flows towards the sea, forming land breeze.

Applications of convection in our daily lives

Application	Explanation
Electric kettle	• The heating element is placed at the bottom of the kettle. • The convection currents formed would circulate all the water, resulting in uniform heating.
Air conditioner	• The appliance is placed near the top of a wall. • Since cold air sinks and hot air rises, the convection currents formed would cool the room efficiently.

Radiation

Radiation is the transfer of thermal energies by emission of electromagnetic waves (EM).

Radiation can take place in vacuum. It does not require any medium.

A hot object **emits** radiation, while a cold object **absorbs** radiation.

Good emitter & absorbers	Poor emitters & absorbers
Black	White/Bright colours
Dull	Shiny surface
Rough	Smooth surface

Poor emitters are also good **reflectors** of radiation.

The amount of radiation transferred depends on:
1) Surface **area** of object
2) Surface **temperature** of object

Design Applications in a Vacuum Flask